

AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1. (previously presented) A method of producing hydrogen comprising:
conducting a reaction between a hydride composition and a
dehydrated hydroxide composition to form hydrogen and an oxide composition, wherein
said hydroxide composition is represented by the formula: $MII^y(OH)_y$, where MII
represents one or more cationic species other than hydrogen and is selected from the
group consisting of Al, As, Ba, Be, Ca, Cd, Ce, Cs, Cu, Eu, Fe, Ga, Gd, Ge, Hf, Hg, In,
La, Li, Mg, Mn, Na, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Se, Si, Sm, Sn, Sr, Th, Ti, Tl, V, W, Y,
Yb, Zn, Zr, and mixtures thereof and y represents an average valence state of MII.

2. (original) The method according to claim 1 wherein said hydride
composition has one or more cationic species other than hydrogen.

3. (original) The method according to claim 2 wherein said oxide
composition comprises at least one of said one or more cations other than hydrogen
derived from either of said hydride or said hydroxide compositions, respectively.

4. (original) The method according to claim 1 wherein said hydride
composition is represented by the formula: MI^xH_x , where MI represents said one or

more cationic species other than hydrogen and x represents an average valence state of MI.

5-6. (cancelled).

7. (previously presented) The method of claim 1 wherein said hydride composition is represented by MI^xH_x , where MI represents one or more cationic species other than hydrogen, and x represents an average valence state of MI.

8. (original) The method of claim 7 wherein MI and MII are different cationic species.

9. (original) The method of claim 7 wherein MI and MII are the same cationic species.

10. (original) The method of claim 7 wherein MI is a complex cationic species comprising two distinct cationic species.

11. (original) The method of claim 7 wherein MII is a complex cationic species comprising two distinct cationic species.

12. (original) The method of claim 7 wherein MI is selected from the group consisting of Al, As, B, Ba, Be, Ca, Cd, Ce, Cs, Cu, Eu, Fe, Ga, Gd, Ge, Hf, Hg, In, K,

La, Li, Mg, Mn, Na, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Se, Si, Sm, Sn, Sr, Th, Ti, Tl, V, W, Y, Yb, Zn, Zr, and mixtures thereof.

13. (cancelled).

14. (previously presented) The method of claim 7 wherein M_I and M_{II} are each elements independently selected from the group consisting of Al, Ba, Be, Ca, Cs, Li, Mg, Na, Rb, Si, Sr, Ti, V and mixtures thereof.

15. (previously presented) The method of claim 14 wherein M_I and M_{II} are each elements independently selected from the group consisting of Al, Be, Ca, Li, Mg, Na, Sr, Ti, and mixtures thereof.

16-23. (cancelled).

24. (original) The method according to claim 1 wherein said hydride composition is selected from the group consisting of: lithium hydride (LiH), sodium hydride (NaH), potassium hydride (KH), beryllium hydride (BeH₂), magnesium hydride (MgH₂), calcium hydride (CaH₂), strontium hydride (SrH₂), titanium hydride (TiH₂), aluminum hydride (AlH₃), boron hydride (BH₃), lithium borohydride (LiBH₄), sodium borohydride (NaBH₄), magnesium borohydride (Mg(BH₄)₂), calcium borohydride (Ca(BH₄)₂), lithium alanate (LiAlH₄), sodium alanate (NaAlH₄), magnesium alanate (Mg(AlH₄)₂), calcium alanate (Ca(AlH₄)₂), and mixtures thereof.

25. (previously presented) The method according to claim 1 wherein said hydroxide composition is selected from the group consisting of: lithium hydroxide (LiOH), sodium hydroxide (NaOH), beryllium hydroxide (Be(OH)₂), magnesium hydroxide (Mg(OH)₂), calcium hydroxide (Ca(OH)₂), strontium hydroxide (Sr(OH)₂), titanium hydroxide (Ti(OH)₂), aluminum hydroxide (Al(OH)₃), and mixtures thereof.

26. (cancelled).

27. (original) The method according to claim 1 wherein said hydride composition comprises LiH and said hydroxide composition comprises LiOH.

28. (original) The method according to claim 27 wherein said reaction proceeds according to a reaction mechanism of $\text{LiH} + \text{LiOH} \rightarrow \text{Li}_2\text{O} + \text{H}_2$.

29. (original) The method according to claim 1 wherein said hydride composition comprises NaH and said hydroxide composition comprises LiOH.

30. (original) The method according to claim 29 wherein said reaction proceeds according to a reaction mechanism of $\text{NaH} + \text{LiOH} \rightarrow \frac{1}{2} \text{Li}_2\text{O} + \frac{1}{2} \text{Na}_2\text{O} + \text{H}_2$.

31. (original) The method according to claim 1 wherein said hydride composition comprises MgH₂ and said hydroxide composition comprises Mg(OH)₂.

32. (original) The method according to claim 31 wherein said reaction proceeds according to a reaction mechanism of $MgH_2 + Mg(OH)_2 \rightarrow MgO + 2 H_2$.

33. (original) The method according to claim 1 wherein said hydride composition comprises AlH_3 and said hydroxide composition comprises $Al(OH)_3$.

34. (original) The method according to claim 33 wherein said reaction proceeds according to a reaction mechanism of $AlH_3 + Al(OH)_3 \rightarrow Al_2O_3 + 3H_2$.

35. (original) The method according to claim 1 wherein said hydride composition comprises CaH_2 and said hydroxide composition comprises $Ca(OH)_2$.

36. (original) The method according to claim 35 wherein said reaction proceeds according to a reaction mechanism of $CaH_2 + Ca(OH)_2 \rightarrow CaO + 2 H_2$.

37. (original) The method according to claim 1 wherein said hydride composition comprises SrH_2 and said hydroxide composition comprises $Sr(OH)_2$.

38. (original) The method according to claim 37 wherein said reaction proceeds according to a reaction mechanism of $SrH_2 + Sr(OH)_2 \rightarrow SrO + 2 H_2$.

39-40. (cancelled).

41. (original) The method according to claim 1 wherein said hydride composition comprises BeH_2 and said hydroxide composition comprises $\text{Be}(\text{OH})_2$.

42. (original) The method according to claim 41 wherein said reaction proceeds according to a reaction mechanism of $\text{BeH}_2 + \text{Be}(\text{OH})_2 \rightarrow \text{BeO} + 2 \text{H}_2$.

43-46. (cancelled).

47. (original) The method according to claim 1 where said hydride composition comprises LiBH_4 and said hydroxide composition comprises LiOH .

48. (previously presented) The method according to Claim 47 where said reaction proceeds according to a reaction mechanism of $\text{LiBH}_4 + 4 \text{LiOH} \rightarrow \text{LiBO}_2 + 2 \text{Li}_2\text{O} + 4\text{H}_2$.

49. (original) The method according to claim 1 where said hydride composition comprises NaBH_4 and said hydroxide composition comprises $\text{Mg}(\text{OH})_2$.

50. (previously presented) The method according to Claim 49 where said reaction proceeds according to a reaction mechanism of $\text{NaBH}_4 + 2 \text{Mg}(\text{OH})_2 \rightarrow \text{NaBO}_2 + 2\text{MgO} + 4\text{H}_2$.

51. (original) The method according to claim 1 where said hydride composition comprises NaBH_4 and said hydroxide composition comprises NaOH .

52. (original) The method according to Claim 51 where said reaction proceeds according to a reaction mechanism of $\text{NaBH}_4 + 4\text{NaOH} \rightarrow \text{NaBO}_2 + 2\text{Na}_2\text{O} + 4\text{H}_2$.

53-69. (cancelled).

70. (original) The method according to claim 1 wherein said reaction is reversible to form a species of said hydride composition or said hydroxide composition.

71. (original) The method according to claim 70 wherein said reversible reaction is conducted by exposing said oxide composition to hydrogen to form said species.

72. (original) The method according to claim 71 wherein said reversible reaction regenerates said hydride composition and said hydroxide composition.

73. (original) The method according to claim 1 wherein said reaction is conducted at an elevated temperature relative to ambient conditions.

74. (original) The method according to claim 73 wherein said reaction is conducted at a temperature 40 °C or greater.

75. (original) The method according to claim 1 wherein said hydride composition and said hydroxide composition are in particle form and said reaction is a solid-state reaction.

76. (original) The method according to claim 75 wherein said hydride composition and said hydroxide composition are reduced in particle size prior to said reaction.

77. (original) The method according to claim 1 wherein before conducting said reaction, said hydride composition and said hydroxide composition are essentially homogeneously mixed together.

78. (original) The method according to claim 1 wherein during said reaction, said oxide composition, said hydrogen, or both, are removed from said hydride composition and said hydroxide composition, as said reaction proceeds.

79. (previously presented) The method according to claim 1 wherein during said reaction said hydrogen is removed as said reaction proceeds.

80. (original) The method according to claim 1 wherein said reaction is conducted in the presence of a catalyst in contact with said hydride composition and said hydroxide composition.

81. (original) The method according to claim 80 wherein said catalyst comprises a compound comprising an element selected from the group consisting of Ti, V, Cr, C, Fe, Mn, Ni, Nb, Pd, Si, Al, and mixtures thereof.

82. (previously presented) A method for releasing hydrogen from hydrogen storage materials comprising:

mixing a first hydrogen storage material with a second hydrogen storage material, where said first hydrogen storage material comprises a hydride composition represented by Mi^xH_x and said second hydrogen storage material comprises a dehydrated hydroxide composition represented by $Mii^y(OH)_y$, where Mi and Mii each represent a cationic species or a mixture of cationic species other than hydrogen, where Mii is selected from the group consisting of Al, As, Ba, Be, Ca, Cd, Ce, Cs, Cu, Eu, Fe, Ga, Gd, Ge, Hf, Hg, In, La, Li, Mg, Mn, Na, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Se, Si, Sm, Sn, Sr, Th, Ti, Ti, V, W, Y, Yb, Zn, Zr, and mixtures thereof, and where x and y represent average valence states of respectively Mi and Mii ; and

conducting a reaction between said first storage material with said second storage material for a time and at a temperature sufficient to produce a reaction product comprising an oxide material and hydrogen.

83. (original) The method of claim 82 wherein Mi and Mii are different cationic species.

84. (original) The method of claim 82 wherein M_I and M_{II} are the same cationic species.

85. (original) The method of claim 82 wherein M_I is a complex cationic species comprising two distinct cationic species.

86. (original) The method of claim 82 wherein M_{II} is a complex cationic species comprising two distinct cationic species.

87. (cancelled).

88. (previously presented) The method of claim 82 wherein M_{II} is selected from the group consisting of CH₃, C₂H₅, C₃H₇, Al, As, Ba, Be, Ca, Cd, Ce, Cs, Cu, Eu, Fe, Ga, Gd, Ge, Hf, Hg, In, La, Li, Mg, Mn, Na, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Se, Si, Sm, Sn, Sr, Th, Ti, Tl, V, W, Y, Yb, Zn, Zr, and mixtures thereof.

89. (previously presented) The method of claim 88 wherein M_I and M_{II} are each elements independently selected from the group consisting of Al, Ba, Be, Ca, Cs, Li, Mg, Na, Rb, Si, Sr, Ti, V and mixtures thereof.

90. (previously presented) The method of claim 89 wherein M_I and M_{II} are each elements independently selected from the group consisting of Al, Be, Ca, Li, Mg, Na, Sr, Ti, and mixtures thereof.

91. (cancelled).

92. (original) The method according to claim 82 wherein said hydride composition is selected from the group consisting of: lithium hydride (LiH), sodium hydride (NaH), potassium hydride (KH), beryllium hydride (BeH₂), magnesium hydride (MgH₂), calcium hydride (CaH₂), strontium hydride (SrH₂), titanium hydride (TiH₂), aluminum hydride (AlH₃), boron hydride (BH₃), lithium borohydride (LiBH₄), sodium borohydride (NaBH₄), magnesium borohydride (Mg(BH₄)₂), calcium borohydride (Ca(BH₄)₂), lithium alanate (LiAlH₄), sodium alanate (NaAlH₄), magnesium alanate (Mg(AlH₄)₂), calcium alanate (Ca(AlH₄)₂), and mixtures thereof.

93. (previously presented) The method according to claim 82 wherein said hydroxide composition is selected from the group consisting of: lithium hydroxide (LiOH), sodium hydroxide (NaOH), beryllium hydroxide (Be(OH)₂), magnesium hydroxide (Mg(OH)₂), calcium hydroxide (Ca(OH)₂), strontium hydroxide (Sr(OH)₂), titanium hydroxide (Ti(OH)₂), aluminum hydroxide (Al(OH)₃), and mixtures thereof.

94. (original) The method according to claim 82 wherein said hydride composition comprises LiH and said hydroxide composition comprises LiOH.

95. (original) The method according to claim 94 wherein said reaction proceeds according to a reaction mechanism of $\text{LiH} + \text{LiOH} \rightarrow \text{Li}_2\text{O} + \text{H}_2$.

96. (original) The method according to claim 82 wherein said hydride composition comprises NaH and said hydroxide composition comprises LiOH .

97. (original) The method according to claim 96 wherein said reaction proceeds according to a reaction mechanism of $\text{NaH} + \text{LiOH} \rightarrow \frac{1}{2} \text{Li}_2\text{O} + \frac{1}{2} \text{Na}_2\text{O} + \text{H}_2$.

98-99. (cancelled).

100. (original) The method according to claim 82 wherein said reaction is reversed by exposing said oxide material to hydrogen to form a regenerated first storage material comprising a hydride and a regenerated second storage material comprising a hydroxide.

101. (original) The method according to claim 100 wherein said hydride of said regenerated first storage material and said hydroxide of said regenerated second storage material are the same species as said first and said second starting materials, comprising said hydride and said hydroxide, respectively.

102. (original) The method according to claim 82 wherein said reaction is conducted at an elevated temperature relative to ambient conditions.

103. (original) The method according to claim 102 wherein said reaction is conducted at a temperature of 40°C or greater.

104. (original) The method according to claim 82 wherein said first starting material and said second starting material are in particle form and said reaction is a solid state reaction.

105. (original) The method according to claim 104 wherein said first starting material and said second starting material are reduced in particle size prior to said reaction.

106. (original) The method according to claim 82 wherein before conducting said reaction, said first starting material and said second starting material are essentially homogeneously mixed together.

107. (original) The method according to claim 82 wherein during said reaction, said oxide, said hydrogen, or both, are removed from said first starting material and said second starting material, as said reaction proceeds.

108. (original) The method according to claim 82 wherein during said reaction said hydrogen is removed from said first and said second starting materials as said reaction proceeds.

109. (original) The method according to claim 82 wherein said reaction is conducted in the presence of a catalyst in contact with said first starting material and said second starting material.

110. (original) The method according to claim 109 wherein said catalyst comprises a compound comprising an element selected from the group consisting of Ti, V, Cr, C, Fe, Mn, Ni, Nb, Pd, Si, Al, and mixtures thereof.

111. (currently amended) A hydrogen storage composition having a hydrogenated state and a dehydrogenated state:

(a) in said hydrogenated state, said composition comprises a hydride represented by Mi^xH_x and a dehydrated hydroxide represented by $Mii^y(OH)_y$, where MI and MII respectively represent one or more cationic species other than hydrogen that are having one or more cationic species other than hydrogen selected from the group consisting of Al, As, Ba, Be, Ca, Cd, Ce, Cs, Cu, Eu, Fe, Ga, Gd, Ge, Hf, Hg, In, La, Li, Mg, Mn, Na, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Se, Si, Sm, Sn, Sr, Th, Ti, Ti, V, W, Y, Yb, Zn, Zr, and mixtures thereof, wherein at least one of MI or MII is a complex cationic species comprising two distinct cationic species and x and y represent average valence states of MI and MII, respectively; and

(b) in said dehydrogenated state, said composition comprises an oxide.

112-118. (cancelled).

119. (currently amended) The composition of claim 111-117 wherein MI is a said complex cationic species comprising two distinct cationic species.

120. (currently amended) The composition of claim 111-117 wherein MII is a said complex cationic species comprising two distinct cationic species.

121. (cancelled).

122. (currently amended) The composition of claim 111 ~~111~~ 117 wherein MII is selected from the group consisting of Al, As, Ba, Be, Ca, Cd, Ce, Cs, Cu, Eu, Fe, Ga, Gd, Ge, Hf, Hg, In, La, Li, Mg, Mn, Na, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Se, Si, Sm, Sn, Sr, Th, Ti, Ti, V, W, Y, Yb, Zn, Zr, and mixtures thereof.

123. (currently amended) The composition of claim 122 wherein MII and MII are each elements independently selected from the group consisting of Al, Ba, Be, Ca, Cs, Li, Mg, Na, Rb, Si, Sr, Ti, V and mixtures thereof.

124. (currently amended) The composition of claim 123 wherein MII and MII are each elements independently selected from the group consisting of Al, Be, Ca, Li, Mg, Na, Sr, Ti, and mixtures thereof.

125-130. (cancelled).

131. (original) The composition of claim 111 wherein said hydride is selected from the group consisting of: lithium hydride (LiH), sodium hydride (NaH), potassium hydride (KH), beryllium hydride (BeH₂), magnesium hydride (MgH₂), calcium hydride (CaH₂), strontium hydride (SrH₂), titanium hydride (TiH₂), aluminum hydride (AlH₃), boron hydride (BH₃), lithium borohydride (LiBH₄), sodium borohydride (NaBH₄), magnesium borohydride (Mg(BH₄)₂), calcium borohydride (Ca(BH₄)₂), lithium alanate

(LiAlH₄), sodium alanate (NaAlH₄), magnesium alanate (Mg(AlH₄)₂), calcium alanate (Ca(AlH₄)₂), and mixtures thereof.

132. (previously presented) The composition of claim 111 wherein said hydroxide is selected from the group consisting of: lithium hydroxide (LiOH), sodium hydroxide (NaOH), beryllium hydroxide (Be(OH)₂), magnesium hydroxide (Mg(OH)₂), calcium hydroxide (Ca(OH)₂), strontium hydroxide (Sr(OH)₂), titanium hydroxide (Ti(OH)₂), aluminum hydroxide (Al(OH)₃), and mixtures thereof.

133. (original) The composition of claim 111 wherein said hydride comprises LiH.

134. (original) The composition of claim 111 wherein said hydroxide comprises LiOH.

135-138. (cancelled).

139. (currently amended) The composition method according to claim 200 111 wherein said hydride composition comprises MgH₂ and said hydroxide composition comprises Mg(OH)₂.

140. (currently amended) The composition method according to claim 139 wherein said reaction proceeds according to a reaction mechanism of $MgH_2 + Mg(OH)_2 \rightarrow MgO + 2 H_2$.

141. (currently amended) The composition method according to claim 200 111 wherein said hydride composition comprises AlH_3 and said hydroxide composition comprises $Al(OH)_3$.

142. (currently amended) The composition method according to claim 141 wherein said reaction proceeds according to a reaction mechanism of $AlH_3 + Al(OH)_3 \rightarrow Al_2O_3 + 3H_2$.

143. (currently amended) The composition method according to claim 200 111 wherein said hydride composition comprises CaH_2 and said hydroxide composition comprises $Ca(OH)_2$.

144. (currently amended) The composition method according to claim 143 wherein said reaction proceeds according to a reaction mechanism of $CaH_2 + Ca(OH)_2 \rightarrow CaO + 2 H_2$.

145. (currently amended) The composition method according to claim 200 111 wherein said hydride composition comprises SrH_2 and said hydroxide composition comprises $Sr(OH)_2$.

146. (currently amended) The composition method according to claim
145 wherein said reaction proceeds according to a reaction mechanism of $\text{SrH}_2 + \text{Sr}(\text{OH})_2 \rightarrow \text{SrO} + 2 \text{H}_2$.

147-148. (cancelled).

149. (currently amended) The composition method according to claim
200 111 wherein said hydride composition comprises BeH_2 and said hydroxide composition comprises $\text{Be}(\text{OH})_2$.

150. (currently amended) The composition method according to claim
149 wherein said reaction proceeds according to a reaction mechanism of $\text{BeH}_2 + \text{Be}(\text{OH})_2 \rightarrow \text{BeO} + 2 \text{H}_2$.

151-154. (cancelled).

155. (currently amended) The composition method according to claim
111 where said hydride composition comprises LiBH_4 and said hydroxide comprises LiOH .

156. (currently amended) The composition method according to claim
155 where said reaction proceeds according to a reaction mechanism of $\text{LiBH}_4 + 4 \text{LiOH} \rightarrow \text{LiBO}_2 + 2 \text{Li}_2\text{O} + 4\text{H}_2$.

157. (currently amended) The composition method according to claim 111 where said hydride composition comprises NaBH_4 and said hydroxide comprises $\text{Mg}(\text{OH})_2$.

158. (currently amended) The composition method according to claim 157 where said reaction proceeds according to a reaction mechanism of $\text{NaBH}_4 + 2 \text{Mg}(\text{OH})_2 \rightarrow \text{NaBO}_2 + 2\text{MgO} + 4\text{H}_2$.

159. (currently amended) The composition method according to claim 111 where said hydride composition comprises NaBH_4 and said hydroxide comprises NaOH .

160. (currently amended) The composition method according to claim 159 where said reaction proceeds according to a reaction mechanism of $\text{NaBH}_4 + 4 \text{NaOH} \rightarrow \text{NaBO}_2 + 2 \text{Na}_2\text{O} + 4 \text{H}_2$.

161-177. (cancelled).

178. (previously presented) A method of producing a source of hydrogen gas comprising:

liberating hydrogen from a solid hydrogenated starting material composition comprising a hydride and a dehydrated hydroxide selected from the group consisting of: lithium hydroxide (LiOH), sodium hydroxide (NaOH), beryllium hydroxide

(Be(OH)₂), magnesium hydroxide (Mg(OH)₂), calcium hydroxide (Ca(OH)₂), strontium hydroxide (Sr(OH)₂), titanium hydroxide (Ti(OH)₂), aluminum hydroxide (Al(OH)₃) and mixtures thereof, by reacting said hydride and said dehydrated hydroxide in a solid state reaction to produce a dehydrogenated reaction product and hydrogen gas.

179. (original) The method according to claim 178 wherein said hydride and said hydroxide each have one or more cationic species other than hydrogen.

180. (original) The method according to claim 178 further comprising regenerating said hydrogenated starting material composition by exposing said dehydrogenated product to hydrogen gas.

181. (original) The method of claim 178 wherein said dehydrogenated product comprises an oxide.

182. (previously presented) The method of claim 180 wherein said regenerating is conducted at an elevated temperature relative to ambient conditions.

183. (original) The method of claim 182 wherein said liberating of hydrogen is conducted at an elevated temperature greater than about 40°C.

184. (original) The method of claim 178 wherein said liberating is conducted by removing said hydrogen gas as said reacting proceeds.

185. (original) The method of claim 178 wherein said liberating is conducted in the presence of a catalyst in contact with said starting material composition.

186. (original) The method according to claim 185 wherein said catalyst comprises a compound comprising an element selected from the group consisting of Ti, V, Cr, C, Fe, Mn, Ni, Nb, Pd, Si, Al, and mixtures thereof.

187-199. (cancelled).

200. (new) A hydrogen storage composition having a hydrogenated state and a dehydrogenated state:

(a) in said hydrogenated state, said composition comprises a hydride represented by Mi^xH_x and a dehydrated hydroxide represented by $Mii^y(OH)_y$, where Mi and Mii respectively represent one or more cationic species other than hydrogen that are selected from the group consisting of Al, Be, Ca, Mg, Sr, and mixtures thereof, wherein x and y represent average valence states of Mi and Mii , respectively; and

(b) in said dehydrogenated state, said composition comprises an oxide.